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Seasonal relative abundance of fish larvae in Helleh River estuary (north of the Persian Gulf, Iran)

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[1]Faculty of Fisheries and Environmental Sciences, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Golestan, Iran. Tel.: +98-917 374 2476, ♥email: mojtabafishery1987@gmail.com
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Abstract. *Paighambari SY, Pouladi M, Parsa M, Mehdipour N, Haghighatjou N, Jabaleh A, Hedayati A. 2017. Seasonal relative abundance of fish larvae in Helleh River estuary (north of the Persian Gulf, Iran). Biodiversitas 18: 541-547.* Study of abundance and composition of fish larvae in order to examine their association with salinity, temperature, dissolved oxygen and transparency was conducted in Helleh River estuary in the north of the Persian Gulf. Samples were collected using Bongo net with 500 µm mesh size and 60 cm mouth diameter size in five selected stations from August 2011 to May 2012. Generally, 1637 fish larvae were isolated from 19 families that most of them were belong to Clupeidae. Seasonal relative abundance (SRA) of fish larvae varied and Clupeidae (39.90%) and Gobiidae (14.35%) in summer; Clupeidae (26.23%) and Sparidae (21.82%) in autumn; Clupeidae (34.43%) and Hemiramphidae (12.02%) in winter; Clupeidae (47.93%) and Sparidae (13.67%) in spring were most abundant than others. Overall, families namely Clupeidae (39.28%), Gobiidae (12.58%) and Sparidae (10.57%) had the highest and Carangidae (0.92%) had the lowest relative abundance during the sampling period. ANOVA test also showed a significant difference between summer and autumn with spring and winter ($P<0.05$). According to CCA, in stations 4 and 5 in summer; stations 5 in autumn; stations 4 and 5 in winter; and stations 4 and 5 in spring with the highest relative abundance of fish larvae, salinity and temperature and partially transparency and in stations 2, 3 and 4 in autumn, stations 2 and 3 in spring, dissolved oxygen had significant correlation with fish larvae abundance in this estuary.

Keywords: Fish larvae, Helleh River, estuary, Persian Gulf, Iran

INTRODUCTION

Estuaries are located among the marine environments and continents and are frequently affected by tide currents and have persistent mixing of freshwaters and salt waters. Estuaries prepare nursery environment for birds, fish and another organism (Calbet et al. 2001; Lam-Hoai et al. 2006). Helleh River is an important ecological area for the growth and reproduction of much tropical fish. The freshwater source of this estuary supplies from Helleh River and creates an estuary system in the south coast of Iran, which originated from southern part of Zagros Mountains. This river receives currents of Shapur and Dalaki rivers at west of Fars Province. It is a permanent river with 170 km length that discharges to the Persian Gulf at 54 km far from Bushehr (ROPME 2003).

Regarding ecological, larvae and adult fishes often assumed quite different and can be considered separated ecological species. They may live in different habitats, different foods and show an entirely different behavior (Leis and Carson-Ewart 2000). The composition of larval assemblages and their correlations to the habitats is so essential to perceive more about the benefits of fishery resources (Faria et al. 2006). The distribution and abundance of fish larvae have a significant relation to the fishery potency of a region and have been considered widely (Kidwai and Amjad 2001). Marine ecosystems situations and climate are associated with fish abundance and distribution. Moreover, the physical environment and food accessibility have been recommended as another main issue to assess the survival rate of larval fish in early stages and the success of population recruitment (Laevastu and Hela 1970; Marshall and Elliott 1998). Study for identification of fish larvae abundance in Persian Gulf have been carried out by Iranian specialists who were mostly focused on the identification and abundance of fish larvae (Rabbaniha 1998; Owfi and Bakhtiary 1999; Dehghan et al. 2000; Jokar and Saraji 2002; Rabbaniha et al. 2008; Vosoughi et al. 2009; Amini et al. 2015). Therefore, the main purpose of this study was to the evaluation of fish larvae assemblages and effects of environmental factors on changes in temporal and spatial patterns of fish larvae composition in Helleh River estuary.

MATERIALS AND METHODS

Study area

The study area was located in the Helleh estuary (latitude= 28° 20' N; longitude= 51° 30' S), in the southwest part of Bushehr province, north of Persian Gulf, Iran. Along Helleh River estuary five sampling stations were determined based on environmental gradients of flow dynamics and mixing of fresh and coastal water, depth,

rivers flow, tides and geomorphological characteristics (Figure 1).

Procedures

Seasonal samplings were conducted at the middle of each season from August 2011 (summer time) to May 2012 (spring time) using a Bongo net with 60 cm diameter and 500 µm mesh size (Smith & Richardson, 1977). Sampling operations were accomplished in high tide times. Towing process was done obliquely and towing time for each determined station was 10 minutes whereas boat speed was around 1 knot h^{-1}. After towing Samples were fixed in 5% formalin in seawater immediately, and transferred to Marine Ecology laboratory of Persian Gulf University. Afterward fish larvae were identified according to valid references at the family level (Leis and Rennis 1983; Leis 1989; Leis and Transky 1989). Water temperature was recorded by Mercury thermometer and salinity was measured using Atago S/Mill refractometer. Dissolved oxygen was also measured by YSI 51 Oxygen meter (Model OH, USA) and transparency was obtained by Secchi depth plate.

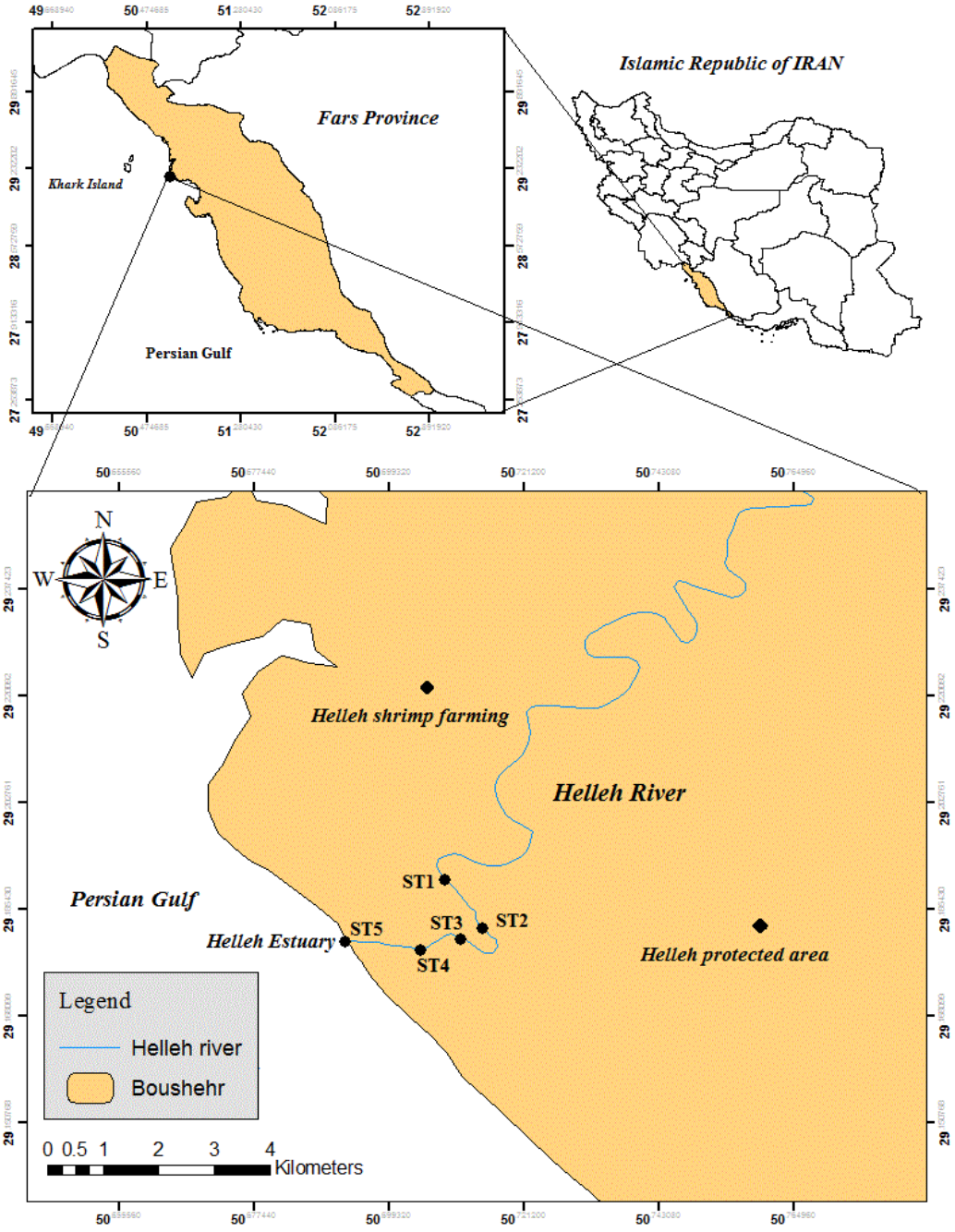

Figure 1. Map of study area showing geographic location and stations in the Helleh River estuary

Data analysis

One-way ANOVA was used to test significant differences in seasonal fish larvae abundance. Data were presented as a mean ± standard error. All data met the parametric test assumptions (normal distribution, homogeneity of variance, independence and randomness of the data). Data was transformed by Arcsin-square root to ensure a normal distribution (Zar 1984). All statistical analysis was carried out using SPSS version 21.0, and cluster analysis was depicted by Biodiversity Pro version 2.0. To assess the relationships between fish larvae abundance in all stations of four seasons with temperature, salinity, dissolved oxygen and transparency canonical correlation analysis was performed using CANOCO version 4.5.

RESULTS AND DISCUSSION

Throughout the study period, a total of 1637 fish larvae belonging to 19 families were identified in Helleh River estuary which 14 families in summer; 12 families in autumn; 11 families in winter; and 14 families in spring were detected. Based on the studies of fish larvae in the south coast of Iran in the Persian Gulf about 54 families have been identified (Rabbaniha et al. 2012), While Richards has listed 103 families for the whole of the Persian Gulf (Richards 2008). Clupeidae family was dominant and present family in all seasons; Gobiidae, Engraulidae, Sillaginidae, Platycephalidae, Teraponidae, Siganidae, Synodontidae, Sphyraenidae, Cynoglosside, Soleidae and Carangidae families were observed in 3 seasons; Sparidae, Gerridae, Lutjanidae, Mugulidae, Hemiramphidae, Scorpaenidae, Belonidae families were observed in 2 seasons during study period (Table 1). Estuary environment is a very important nursery for many fish larvae and juveniles of other estuarine species (Strydom et al. 2003). Most marine fishes which are dependent on estuary environment enter these ecosystems within the postflexion phase of their larval stage (Strydom and Whitfield 2000).

Fish larvae abundance at stations 1, 2, 3, 4 and 5 were 29, 38, 71, 108 and 172 individuals in summer; 24, 35, 62, 96 and 168 individuals in autumn; 12, 17, 20, 42 and 92 individuals in winter and 36, 47, 98, 164 and 307 individuals in spring, respectively (Figure 2). The seasonal abundance of fish larvae were 418, 385,183, and 652 individual in summer, autumn, winter and spring, respectively. Also, the highest fish larvae abundance were recorded at station 5 (estuary mouth) throughout the year. According to ANOVA test, there were significant differences ($P<0.05$) between summer and autumn with spring and winter (Figure 3). In some estuarine environments, peaks in fish larvae abundance seem to be correlated with peaks in phytoplankton production and biomass. During winter light intensity and temperature diminish and, therefore, zooplankton and phytoplankton biomass decrease to very low levels, therefore decreasing fish populations is expected (Kennish 1986; Livingston et al. 1997; Garcia et al. 2003).

Table 1. Comparison of fish larvae presence (*) during different seasons in Helleh River estuary, north of the Persian Gulf, Iran

Family	Summer 2011	Autumn 2011	Winter 2012	Spring 2012
Clupeidae	*	*	*	*
Gobiidae	*	*		*
Sparidae		*		*
Engraulidae	*	*		*
Sillaginidae	*		*	*
Gerridae		*		*
Lutjanidae	*		*	
Platycephalidae	*	*		*
Teraponidae	*	*	*	
Siganidae	*		*	*
Mugilidae	*		*	
Hemiramphidae	*		*	
Synodontidae	*	*	*	
Sphyraenidae		*	*	*
Scorpaenidae		*		*
Belonidae		*		*
Cynoglossidae	*		*	*
Soleidae	*		*	*
Carangidae	*	*		*

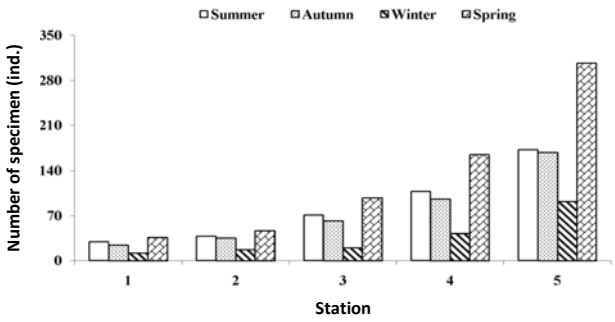

Figure 2. Seasonal abundance of fish larvae at different stations in the Helleh River estuary, north of the Persian Gulf, Iran

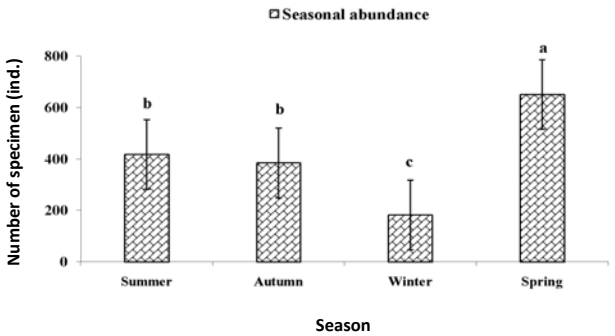

Figure 3. Total number of fish families' specimens during study period in Helleh River estuary, north of the Persian Gulf, Iran

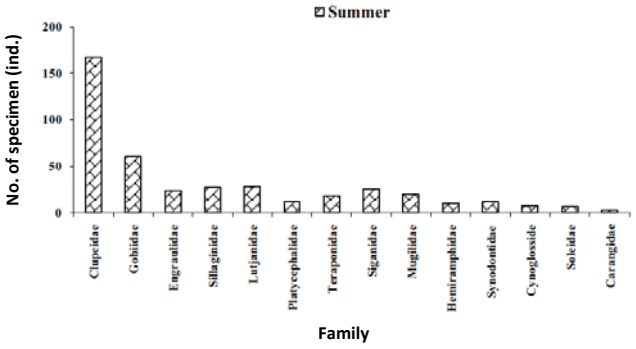

Figure 4. Number of fish families' specimens in summer in Helleh River estuary, north of the Persian Gulf, Iran

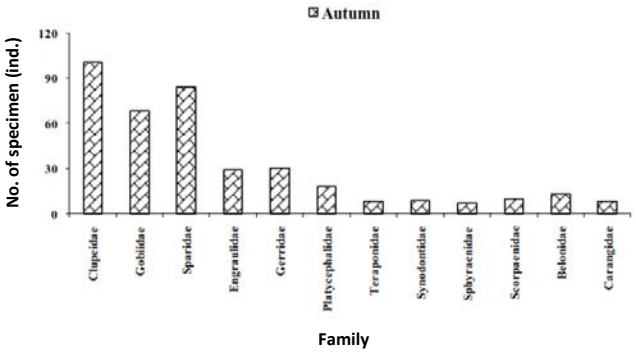

Figure 5. Number of fish families' specimens in autumn in Helleh River estuary, north of the Persian Gulf, Iran

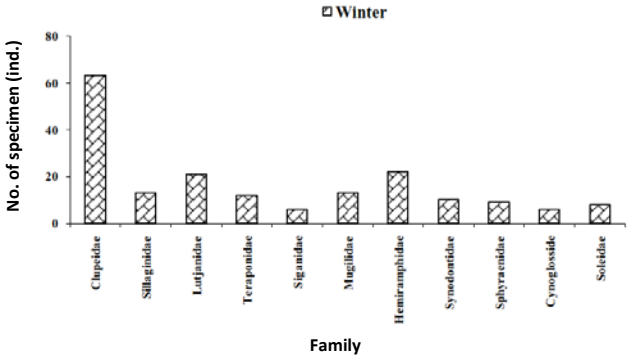

Figure 6. Number of fish families' specimens in winter in Helleh River estuary, north of the Persian Gulf, Iran

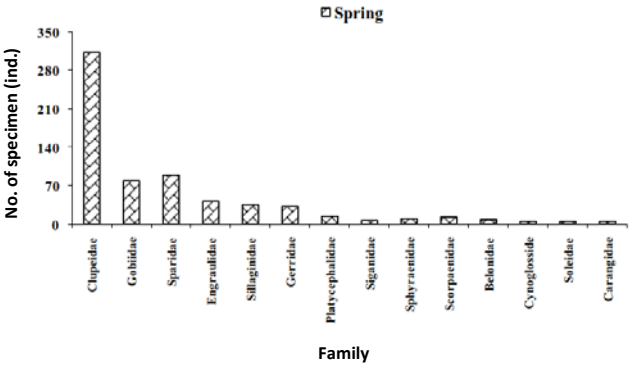

Figure 7. Number of fish families' specimens in spring in Helleh River estuary, north of the Persian Gulf, Iran

Table 2. List of fish larvae families identified in the Bongo-net collections (August 2011 to May 2012)

Family	No. of specimen	Relative abundance
Clupeidae	643	39.28
Gobiidae	206	12.58
Sparidae	173	10.57
Engraulidae	94	5.74
Sillaginidae	75	4.58
Gerridae	63	3.85
Lutjanidae	49	2.99
Platycephalidae	44	2.69
Teraponidae	38	2.32
Siganidae	37	2.26
Mugulidae	33	2.02
Hemiramphidae	32	1.95
Callionymidae	31	1.89
Sphyraenidae	25	1.53
Scorpaenidae	22	1.34
Belonidae	21	1.28
Cynoglosside	18	1.10
Soleidae	18	1.10
Carangidae	15	0.92
Total	1637	100

According to the seasonal collected fish larvae samples Clupeidae with 167 individuals and 39.9% abundance percentage and Gobiidae with 60 individuals and 14.35% abundance percentage in summer; Clupeidae with 101 individuals and 26.23% abundance percentage and Sparidae with 84 individuals and 21.82% abundance percentage in autumn; Clupeidae with 63 individuals and 34.43% abundance percentage and Hemiramphidae with 22 individuals and 12.02% abundance percentage in winter; Clupeidae with 312 individuals and 47.93% abundance percentage and Sparidae with 89 individuals and 13.67% abundance percentage in spring showed the highest abundance percentage among the fish larvae which were identified (Figure 4; Figure 5; Figure 6; Figure 7). A total of four seasons, Clupeidae with 643 individuals and 39.28% abundance percentage, Gobiidae with 206 individuals and 12.58% abundance percentage and Sparidae with 173 individuals and 10.57% abundance percentage had the highest amounts of abundance and Carangidae with 15 individuals and 0.92% abundance percentage had the lowest amount of abundance, respectively (Table 2).

Clupeidae can be considered as an indicator of the changes in this estuary. Clupeidae family as a pelagic fish produces pelagic eggs and their larvae reach to the rich regions and coastal food by sea current and their presence in coastlines and estuaries can be linked with the peak period of zooplankton and phytoplankton production (Keenleyside, 1979). The community structures and temporal and spatial patterns determined in this research showed similar results with other studies in Persian Gulf region (Rabbaniha 1998, Owfi and Bakhtiary 1999; Jokar and Saraji 2002; Rabbaniha et al. 2013, Amini et al. 2015). The studied habitats in their researches were coastal,

estuary and creek that Clupeidae and Gobiidae were the dominant family assemblages. The distribution and abundance of fish larvae depend on desirable biological situations, time and place of fish spawning that will ensure the existence of suitable and sufficient food, and least threat from predators and unsuitable ecological situations (Wootton 1990; Whitfield 1998). However suitable temperature regimes found in estuaries permit fish larvae to complete their evolution into juveniles with better success. Some fish species settle in nursery estuaries until their Sexual maturation (Whitfield 1998).

On the other hand, in terms of the seasonal abundance of fish larvae families, two main groups were indicated by cluster analysis. In this analysis, Clupeidae family at the 50% level of the similarity was separated than other families. Spatial and temporal patterns of fish larvae distribution and abundance are associated with their reproductive tactics and life cycle stages that are mostly linked with meteorological and oceanographic characteristics. This can be attributed to the spawner fishes that start the breeding process within spring and in the early of summer (Hernández-Miranda et al. 2003).

The seasonal average of water transparency and salinity were 44.4 cm and 39.4 ppt in summer; 48 cm and 37.6 ppt in autumn; 50 cm and 17.2 ppt in winter and 45.2 cm and 27.8 ppt in spring, respectively. The seasonal average of temperature and dissolved oxygen were 32.4 °C and 6.77 mg L^{-1} in summer; 19.2 °C and 7.14 mg L^{-1} in autumn; 13.58 °C and 11.26 mg L^{-1} in winter, and 23.04 °C and 8.38 mg L^{-1} in spring, respectively (Table 3).

Effects of some environmental variables on fish larvae abundance are tested by canonical component analysis (CCA) (Figure 9). Based on CCA during this study period, in stations 4 and 5 in summer; stations 5 in autumn; stations 4 and 5 in winter; and stations 4 and 5 in spring with the highest amounts of fish larvae, salinity, and temperature and partial transparency were effective factors, respectively. Also in stations 2, 3 and 4 in autumn, stations 2 and 3 in spring, dissolved oxygen showed a positive correlation with fish larvae abundance, respectively.

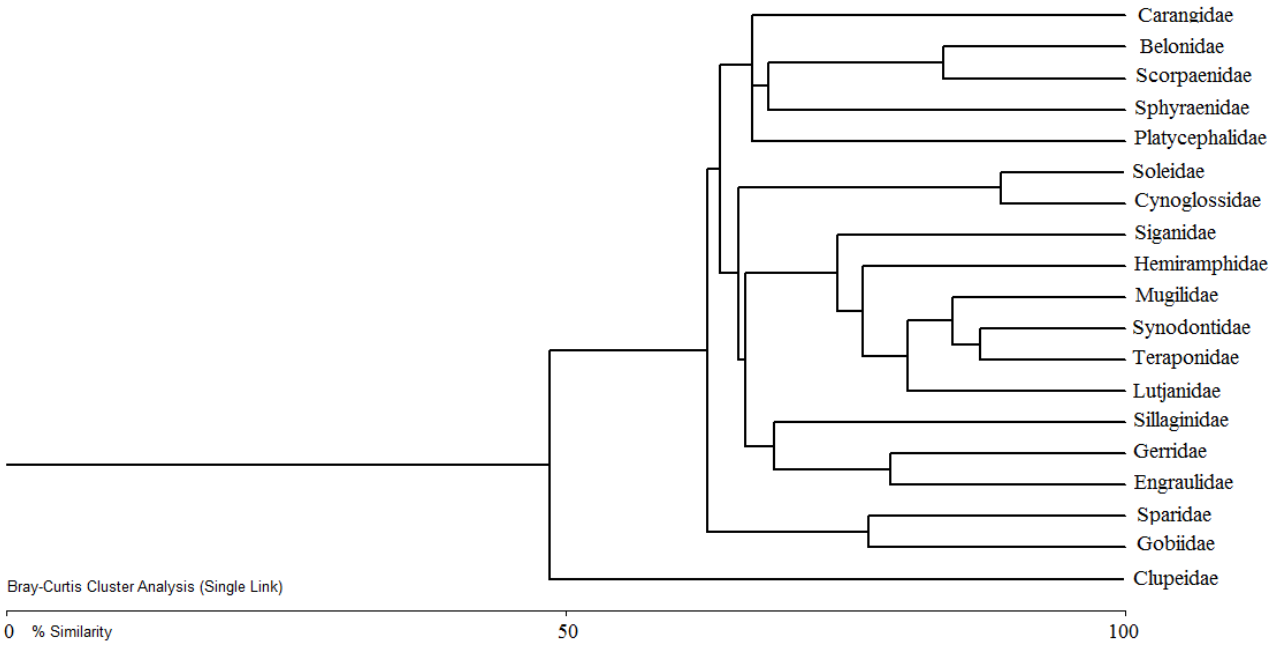

Figure 8. Annual Bray-Curtis cluster analysis of fish larvae families based on abundance in Helleh River estuary, north of the Persian Gulf, Iran

Table 3. Mean (±SE) of water quality factors in different seasons in Helleh River estuary (0.05> P)

Parameter	Summer 2011	Autumn 2011	Winter 2012	Spring 2012
Salinity (ppt)	39.4±1.2^{a}	37.6±1.96^{a}	17.2±6.28^{b}	27.8±6.39^{b}
Transparency (cm)	44.4±0.67^{b}	48±1.22^{ab}	50±1.58^{a}	45.2±1.77^{b}
Dissolved Oxygen (mg L^{-1})	6.77±0.4^{c}	7.14±0.14^{c}	11.26±0.39^{a}	8.38±0.18^{b}
Temperature (°C)	32.4±1.1^{a}	19.2±0.13^{c}	13.58±0.23^{d}	23.04±0.59^{b}

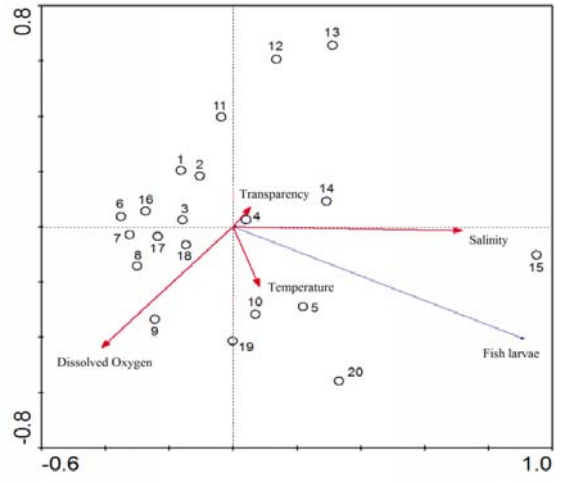

Figure 9. CCA analysis related to one year study period: (1-5) summer stations, (6-10) autumn stations, (11-15) winter stations, (16-20) spring stations

Estuaries are distinguished by environmental fluctuations, where sudden changes in salinity, temperature, oxygen and turbidity happen due to the influx of tides and the mixing of marine and freshwater currents (Dyer 1997; McLusky and Elliott 2004). The effects of water physicochemical features on fish assemblage abundance, composition, and distribution in estuarine environments have been investigated by different authors in subtropical and tropical ecosystems (Castillo-Rivera et al. 2002; Barletta-Bergan et al. 2002; Simier et al. 2006). Salinity as an effective factor in development, growth and stress level of marine fish is well known (Chesalina et al. 2013). Water salinity and temperature are two main factors affecting fish distribution among and within estuarine environments and have been shown to play an important role in the occurrence, density and growth of the larval stages of fishes (Rakocinski et al. 1996; Strydom et al. 2003). The changes in salinity range and other water factors such as temperature, dissolved oxygen, pH and conductivity happen for the reasons of the effects of tides and mixing of fresh water and marine water (Marshall and Elliott 1998).Temperature as the primary abiotic parameter is controlling the physiological and biochemical processes during fish life period and influences the utilization of estuaries ecosystems by fish species (Harrison and Whitfield 2006). Fishes have an optimal temperature range that improves their physiological processes (Selleslagh and Amara 2008). Water temperature is related to the weather thermal cycle situations and ranged according to seasonal conditions in estuaries and abrupt fluctuation in water temperature can cause fish mortality (Blaber 2000).

Transparency as a hydrological parameter is playing a key role in fish larvae distribution. Turbidity impressed the estuarine fish in three main modes: it may protect juvenile fish from predators; it is associated with areas rich in food abundance, and it might prepare a tendency mechanism for bilateral migration to the estuary (Blaber 2000). Maes et al. (2004) stated dissolved oxygen is an important factor for distribution and abundance of fish in estuaries. Dissolved oxygen causes the survival of fish especially in juvenile and fry stages, and it is a vital variable in estimating the water quality in estuaries because low dissolved oxygen level of a water body affects the survival rate of aquatic organisms, and consequently changes the ecological stability of a estuary ecosystem (Zheng et al. 2004). The Fluctuations in dissolved oxygen of estuaries is affected by biochemical and physical processes (Ambrose et al. 1993; Chen 2003).

To conclude, this research investigated the pattern of fish larvae composition in Helleh River estuary, Bushehr province. The fish larvae composition was dominated by Clupeidae, Gobiidae and Sparidae families and most abundance were observed in station 5 in the mouth area of the estuary during the sampling period. Also, our results showed that spatial and temporal changes in fish larvae assemblages were linked to environmental conditions which there was significant correlation between Fish larvae abundance with salinity, temperature and dissolved oxygen in the study area. In the end, it is recommended to consider the relationship between fish larvae assemblages with plankton and benthos assemblages for a better understanding of relationships in food webs in the estuary ecosystem.

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